Table I. Continued.

	CEA	*CAS + EPD*	*CAS + FRS*	P *values*		
Overall	*n = 226*	*n = 216*	*n = 53*	*Overall*	*CEA/ EPD*	*CEA/ FRS*
ASA therapy	91%	91%	81%	.104	.81	.038
Coumadin therapy	8%	8%	0%	.019	.97	.006

CAS, Carotid artery stenting; *CAS + EPD,* carotid artery stenting plus distal embolic filter protection; *CAS + FRS,* carotid artery stenting plus flow reversal system protection; *CEA,* carotid endarterectomy; *CEA/EPD,* comparison of CEA versus CAS + EPD; *CEA/FRS,* comparison of CEA versus CAS + FRS.

Table II. Primary events at 30 days

	CEA	*CAS + EPD*	*CAS + FRS*	P *value*		
Overall	*n = 226*	*n = 216*	*n = 53*	*Overall*	*CEA/ EPD*	*CEA/ FRS*
MAE	4.0% (8)	5.1% (9)	0.0% (0)	.100	.61	.15
Stroke	2.0% (4)	4.0% (7)	0.0% (0)	.131	.26	.18
Minor Stroke	0.5% (1)	3.4% (6)	0.0% (0)	.070	.031	.50
Major Stroke	1.5% (3)	0.6% (1)	0.0% (0)	.400	.36	.24
MI	0.0% (0)	0.0% (0)	0.0% (0)	-	-	-
Death (n = 425)	1.5% (3)	1.7% (3)	0.0% (0)	.464	.88	.24

CAS, Carotid artery stenting; *CAS + EPD,* carotid artery stenting plus distal embolic filter protection; *CAS + FRS,* carotid artery stenting plus flow reversal system protection; *CEA,* carotid endarterectomy; *CEA/EPD,* comparison of CEA versus CAS + EPD; *CEA/FRS,* comparison of CEA versus CAS + FRS.

Endovascular Aneurysm Repair and the Anatomic Severity Grading Score: A Validation Study with Early Outcomes and Cost Analysis

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Background: Endovascular aneurysm repair (EVAR) is an established alternative to open surgery for the management of abdominal aortic aneurysms (AAA). It is commonly understood that the anatomic complexity of an aneurysm impacts the technical difficulty of repair. Yet, little research has been done to correlate the relationship of aneurysm anatomy to technical difficulty and early outcomes. Additionally, the anatomic diversity of aneurysms makes outcome comparisons in the literature difficult to interpret. Adjusting for aneurysm anatomic variability thus provides one method to obtain some measure of confidence in comparing outcomes in the literature. The objective of adjusting for anatomic variability is best achieved with scoring schemes incorporating all factors affecting the outcomes being assessed. Grading scales to define the severity of anatomic factors have been reported and validated for lower-extremity peripheral vascular and venous disease. Accordingly in 2002, a system for the grading of abdominal aortic aneurysms was developed by the Society for Vascular Surgery/American Association for Vascular Surgery (SVS/AAVS). The calculated score assumes that the components of the score influence the difficulty of EVAR. Unfortunately, the correlation of anatomic severity grading (ASG) score to patient outcomes within a database has yet to be validated. Accordingly, we provide our experience with calculating ASG score using M2S 3D image rendering software and provide the practical translation of this score into early outcomes.

Methods: All patients who underwent an EVAR for infrarenal AAA between April 2009 and July 2010 by the Division of Vascular Surgery at Eastern Virginia Medical School were retrospectively identified using CPT codes 34800, 34803, 34804, and 34805. To minimize the number of confounding variables, we limited our study to patients who had placement of a Talent™ or Aneurx™ endograft (Medtronic®, Minneapolis, MN) and who had preoperative M2S imaging (M2S©, West Lebanon, NH). Patients who underwent EVAR for ruptured aneurysm, aortoiliac occlusive disease, or penetrating abdominal aortic ulcers were excluded. A retrospective chart review of the electronic medical record was completed. Recorded patient demographic information included age, sex, past medical history, risk factors, and indication for operation. Indication for operation was defined as either asymptomatic or symptomatic. All measurements were based on the planned deployment site as determined by preoperative imaging. Operative records and postoperative visits were also examined and intraoperative procedural data and outcomes were recorded accordingly to the SVS/AAVS guidelines. Lastly, operative supply costs and hospital charge information was obtained from the billing department. The total ASG score for each patient was calculated based on aortic neck, aneurysm, and iliac anatomic factors, such as diameter, length, angulation, and tortuosity according to the SVS/AAVS guidelines. The mean total ASG score for the data set was then used to create two independent patient groups: a low ASG score group (score <14) and a high ASG score group (score of ≥ 14). Both groups were compared for intraoperative and 30-day outcomes including the use of adjunctive procedures, operating room supply cost, and hospital charges. Values are given as mean $\pm$ standard deviation unless otherwise noted. Fisher exact test and Student t test were used to compare nominal and continuous variables respectively for the two independent groups. P value less than .05 was considered statistically significant.

Results: Of the 157 patients who underwent EVAR during the 16-month study period, a total of 108 patients met our inclusion criteria. The remaining 49 patients were excluded because of their ruptured or nonaneurysmal indication for repair, lack of preoperative M2S imaging, or use of alternative endograft. The mean time interval between preoperative imaging and EVAR was 3 months. The mean age was 75 years (range 60-88 years). A majority of patients were male (78%), Caucasian (81%), and asymptomatic (91%). Seventy-percent of patients received the Talent endograft and the remaining 30% received the Aneurx endograft. Ninety-seven percent of patients received bifurcated endografts, while the remaining 3% received uni-iliac endografts. There were 56 patients in the low ASG group and 52 in the high ASG group. Demographic data, risk factors, indications, and endografts were comparable between the two groups. Intraoperative outcomes were significantly different in the low score group vs high score group: operative time (113 minutes vs 210 minutes, $P < .0001$), blood loss (227 mL vs 866 mL, $P = .0002$), and amount of contrast used (100 mL vs 131 mL, $P = .032$). The low score group also used an average of three endograft implants during the case, whereas the high score group used an average of four ($P = .001$). Access site adjuncts were 14% in the low score group compared to 50% in the high score group ($P < .0001$). Endarterectomy, patch angioplasty, and percutaneous angioplasty were the most common access site adjuncts. Intraoperative adjuncts were 54% in the low score group vs 80% in the high score group ($P = .004$). Distal limb extension, access site management, and iliac artery occlusive disease management were the most common adjuncts. Seventy-five percent of these adjuncts were endovascular. EVAR was technically successful in all patients, with no conversions to an open repair. No statistical difference in the incidence of graft limb issues such as kinking, twisting, or stenosis between the two groups were identified (14% low ASG group vs 4% high ASG group, $P = .06$). The average length of hospital stay was 3 days. The average length of hospital stay for the low score group was 2 days and for the high score group was 5 days ($P = .012$). Postoperatively, our mean follow-up length was 5 months. There were no deaths within 30 days of the procedure and no aneurysm related deaths during follow up. Two individuals (3.7%) died during extended follow-up, both belonging to the high anatomic score group. Total supply cost and charges related to aneurysm repair also differed based on ASG score. Mean operating room supply cost was \$16,646 for the low score group vs \$25,765 for the high score group ($P = .006$). Mean total hospital charge was \$70,956 for the low score group vs \$105,153 for the high score group ($P = .016$). The difference in technical difficulty of EVAR in the high vs low ASG score group is evident in the details of the operation. Operative time was 46% longer, 24% more contrast was used, and blood loss was 74% more in the high anatomic score group. These results are despite equivalent devices being used. EVAR for the high vs low ASG score had more endograft implants used (3 vs 4), 36% more access adjuncts, and 26% more intraoperative adjuncts. The high ASG category translated into a 55% increase in operating room supply costs and a 48% increase in hospital charges.

Conclusions: The ultimate utility of our study lies in its ability to provide a framework for interpreting anatomic score into a clinically applicable outcome of anticipated operative difficulty and expected outcomes, defined by operative time, equipment needs, costs, and early outcomes. We illustrated that a high anatomic score correlates with increased operating times, length of hospital stay, blood loss, contrast use, and costs. We demonstrated that with the use of the M2S software, one is able to quantitatively describe the anatomic severity of aortic aneurysms. This score was an important indicator of potential technical difficulties requiring more endovascular implants and adjunctive maneuvers during EVAR.

Mesenteric/Celiac Duplex Ultrasound Interpretation Criteria Revisited

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Background: Several published studies with limited sample size have reported conflicting results of duplex (DUS) ultrasound utilizing different threshold velocities in detecting significant stenosis (st.) of SMA or celiac arteries (CA). This is the largest study to analyze various published diagnostic criteria of SMA/CA st.